WHAT IS CLAIMED IS:

1. A semiconductor device, comprising:

a one-conduction type semiconductor substrate;

a one-conduction type semiconductor layer formed on the substrate;

a plurality of first reverse-conduction type semiconductor regions formed in the semiconductor layer;

a second reverse-conduction type semiconductor region formed around the semiconductor layer so as to surround the plurality of first reverse-conduction type semiconductor regions; and

a metal layer forming Schottky junctions in cooperation with the semiconductor layer and surfaces of the first reverse-conduction type semiconductor regions.

2. The semiconductor device according to Claim 1, wherein the first reverse-conduction type semiconductor regions are formed by burying reverse-conduction type semiconductor material into trenches formed in the semiconductor layer.

3. The semiconductor device according to Claim 1, wherein the first reverse-conduction type semiconductor regions are formed by diffusing reverse-conduction type impurities into the semiconductor layer.

4. The semiconductor device according to Claim 1, wherein the respective neighboring first reverse-conduction type semiconductor regions are disposed so as to be spaced from one another at such intervals that the semiconductor layer between neighboring first reverse-conduction type semiconductor regions is fully filled in a depletion layer when reverse voltages are applied.

5. The semiconductor device according to Claim 1, wherein respective neighboring first reverse-conduction type semiconductor regions are disposed so as to be spaced from one another at substantially equal intervals.

6. The semiconductor device according to Claim 1, wherein the first reverse-conduction type semiconductor regions are formed with a thickness smaller than the thickness of the semiconductor layer.

7. The semiconductor device according to Claim 1, wherein the second reverse-conduction type semiconductor region is a diffusion region.

8. The semiconductor device according to Claim 1, wherein the second reverse-conduction type semiconductor region is formed by burying semiconductor material into a plurality of trenches formed in the semiconductor layer.

9. A method for manufacturing a semiconductor device, comprising:

laminating a one-conduction type semiconductor layer on a one-conduction type semiconductor substrate;

forming, in the semiconductor layer, a plurality of first reverse-conduction type semiconductor regions and a second reverse-conduction type semiconductor region surrounding the plurality of first reverse-conduction type semiconductor regions; and

forming a metal layer that forms Schottky junctions in cooperation with the semiconductor layer and surfaces of the first reverse-conduction type semiconductor regions.

10. A method for manufacturing a semiconductor device according to Claim 9, wherein the first reverse-conduction type semiconductor regions are formed by ion-implanting and diffusing impurities.

11. A method for manufacturing a semiconductor device according to Claim 9, wherein the first reverse-conduction type semiconductor regions are formed by forming trenches in the semiconductor layer and burying reverse-conduction type semiconductor material in the trenches.

12. A method for manufacturing a semiconductor device according to Claim 9, wherein the second reverse-conduction type semiconductor region is formed by forming a plurality of trenches in the semiconductor layer and burying reverse-conduction type semiconductor material in the trenches.

13. A method for manufacturing a semiconductor device according to Claim 9, wherein the first reverse-conduction type semiconductor regions and the second reverse-conduction type semiconductor region are simultaneously formed.

14. A semiconductor device, comprising:

a one-conduction type semiconductor substrate;

a one-conduction type semiconductor layer formed on the substrate;

at least one reverse-conduction type semiconductor region formed in the semiconductor layer;

a metal layer forming a Schottky junction area in cooperation with the semiconductor layer and surfaces of the at least one reverse-conduction type semiconductor region; and

said at least one reverse-conduction type semiconductor region being configured such that the semiconductor layer in a Schottky junction area is fully filled in a depletion layer when a reverse voltage is applied.

15. The semiconductor device of claim 14, wherein said at least one reverse-conduction type semiconductor region includes: a plurality of first reverse-conduction type semiconductor regions formed in the semiconductor layer; and a second reverse-conduction type semiconductor region formed around the semiconductor layer so as to surround the plurality of first reverse-conduction type semiconductor regions.

16. A semiconductor device, comprising:

a substrate;

a semiconductor layer on the substrate;

a metal layer forming a Schottky junction area in cooperation with the semiconductor layer;

means for fully filling the semiconductor layer in the Schottky juntion area in a depletion layer when a reverse voltage is applied such as to pinch off the semiconductor layer so as to suppress an IR leak current.

17. The semiconductor device of claim 16, wherein the means for fully filling includes: a plurality of first reverse-conduction type semiconductor regions formed in the semiconductor layer; and a second reverse-conduction type semiconductor region formed around the semiconductor layer so as to surround the plurality of first reverse-conduction type semiconductor regions.